The Re-establishment of the Ostracod Fauna of Llangothlin Lagoon after a Drought

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Within three months of refilling after a period of drought a fauna of up to seven species of Ostracoda was re-established in Llangothlin Lagoon. These species belong to six genera: *Cypretta, Newnhamia, Ilyodromus, Candonocypris, Heterocypris,* and *Gomphodella.* Five species of the first four genera were commonly found but *Heterocypris* disappeared from the fauna within six months of inundation and only one individual of *Gomphodella* was found. Brief descriptions and ecological notes for each species are given.

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INTRODUCTION

Llangothlin Lagoon is a shallow, freshwater lake approximately 18 km NNE of Guyra on the New England Tablelands of New South Wales. It lies at an elevation of 1,350 m above sea level. It has a surface area of approximately 400 ha when full and the maximum depth is probably no more than 1.6 m (Briggs, 1976). Average annual rainfall at Guyra is 900 mm with summer rainfall predominating. The years 1979 and 1980 had well below average rainfall with totals of only 687 and 591 mm respectively being recorded. The early part of 1981 was also abnormally dry but significant rains fell in May and June and the total for the year was near, but still below, average.

Although generally regarded as a permanent water body Llangothlin Lagoon was dry for an unverifiable period in the summer and autumn of 1980-81 (probably not more than seven months) but it began filling again in early June 1981. In July, 1982, its surface area was roughly 0.75 of 'normal', i.e. about 300 ha. Complete drying out of this lagoon is infrequent, occurring possibly once every thirty years or so. It has proved impossible to get a consensus on the matter from local inhabitants.

Monthly sampling of the invertebrate fauna was begun in August 1981. Four species of ostracod were present at the first sampling. The maximum number of species, seven, was present in November.

Data for this paper were collected as part of a detailed ecological investigation of four lagoons in the Guyra region currently being undertaken by one of the authors (J.M.B.) for a Masters thesis at the University of New England.

METHODS

Open water, vegetation, and mud samples, were taken from each of a number of submerged transect points at the southern end of the lagoon. Samples were collected between August, 1981, and July, 1982, inclusive. The maximum mean depth along the transect was 46 cm recorded in April, 1982. From time to time additional samples were collected from sites other than the fixed transect points.

Duplicate open water samples were collected at each point using a perspex tube 4.5 cm in diameter allowing a column of water of known volume to be taken. Samples included species from all depths, from the mud-water interface to the surface. Any predators were removed from the samples in the field.

Vegetation was clipped from 30 cm^2 quadrats at each point and all plant material above approximately 1 cm from the bottom was collected. The clipped vegetation was placed in plastic bags with sufficient water to prevent dehydration of either plants or animals during transport to the laboratory. In the laboratory all plant material was washed thoroughly and inspected for the removal of all animals. The water in which the plants were washed was collected and filtered through a fine terylene cloth; any animals remaining in the filtrate were added to the sample.

Mud cores to a depth of 5 cm were taken with a split corer of 5.2 cm diameter. Due to technical problems, mud samples were not collected in August, 1981, or May, 1982.

All samples were taken back to the laboratory, packed in ice in the summer, within a few hours of collection. They were then refrigerated until they could be sorted. Sorting was completed within three or four days of collection.

All animals were removed live from the sample with the aid of a desk magnifier and preserved in 80% alcohol for later identification. This method allows for the detection of any specimen greater than 0.2 mm in size.

Specimens are currently held at the University of New England but will be deposited with the Australian Museum.

Results and Discussion

(a) *The Habitat*

Apart from a period of approximately seven to ten days in late February, 1982, all regular sampling points, except one in the middle of the transect, were submerged from early July, 1981. The one point that was not, was above water level in September, 1981, and early February, 1982, but in neither instance did the bottom mud dry out.

At the beginning of the sampling period the dominant macrophyte along the transect was water meadow grass, *Glyceria* sp., with *Myriophyllum propinquum* as co-dominant at the transect point furthest from the shore. At that time vegetation cover was much less than 50%. As the water meadow grass died off *Myriophyllum* replaced it and was dominant from October, 1981, providing 80-100% of the botanical composition. Other macrophytes in the sample area were *Eleocharis sphacelata* and *Potamogeton* sp.

Vegetation cover at all regular sampling points was greater than 90% from November, 1981. From March to the end of sampling in July, 1982, all sites had 100% cover.

b. *The Ostracod Fauna: Species Description and Ecological Notes*

1. Cypretta minna (King, 1855)

Size: females 1.0 mm; males 0.85 mm. Figs 1, 2.

The genus is cosmopolitan (McKenzie, 1980) and this species is yellowish with green patches when mature. It is hairy and has distinct radial septa in both valves. Juveniles are a vivid green.

C. minna is an active swimmer and is found both in open water and in association with plants, but more frequently the latter. However, the relationship appears to be with the algae that are associated with the macrophytes rather than with the larger plants themselves. The species was present throughout the sampling period with both adults and juveniles collected on most occasions except in March, 1982, when virtually

TABLE 1
Mean Monthly Densities of Ostracods 1981-82

	C. minna[a]		*N. fenestrata*[a]		*Ilyodromus* spp.[b]		*C. candonioides*[b]		*H. vatia*[b]	
	$\bar{x}$	s.d	$\bar{x}$	s.d	$\bar{x}$	s.d	$\bar{x}$	s.d	$\bar{x}$	s.d
Aug	4.2	4.6	—	—	P		—	—	P	
Sep	5.4	7.7	5.4	7.5	P		—	—	2700	2225
Oct	4.9	3.6	18.2	23.0	1167	1366	—	—	2785	1799
Nov	49	108	37.4	33.8	9150	9869	1444	2068	444	391
Dec	9.9	16.0	134	128	9500	8660	83	204	—	—
Jan	13.4	9.1	2.4	3.7	23916	27855	—	—	—	—
Feb	11.2	7.6	4.9	5.2	11750	10093	928	2029	—	—
Mar	15.9	16.1	11.1	9.0	3750	3029	83	204	—	—
Apr	9.1	5.6	2.2	2.6	3583	4329	—	—	—	—
May	16.3	5.8	1.2	2.5	—	—	—	—	—	—
Jun	3.9	3.2	P*		467	533	83	204	—	—
Jul	3.1	2.3	0.2	0.6	554	816	—	—	—	—

a = no/litre
b = no/metre^2
P = present, but sample unquantified. Density expressions are related to sampling methods
* See text

no adults were present. This sampling immediately followed the brief period during which the transect was above water.

Mean densities for *C. minna* and all other species except *Gomphodella australica,* are given in Table 1.

2. *Newnhamia fenestrata* (King, 1855)

Size: females 0.85 mm, males 0.80 mn; Fig. 3.

Mature individuals of this species are dark brownish to almost black. They have a ribbed and flattened ventral surface, plus 2 distinctive eye tubercles. The genus is endemic to the Australian Zoogeographical Region.

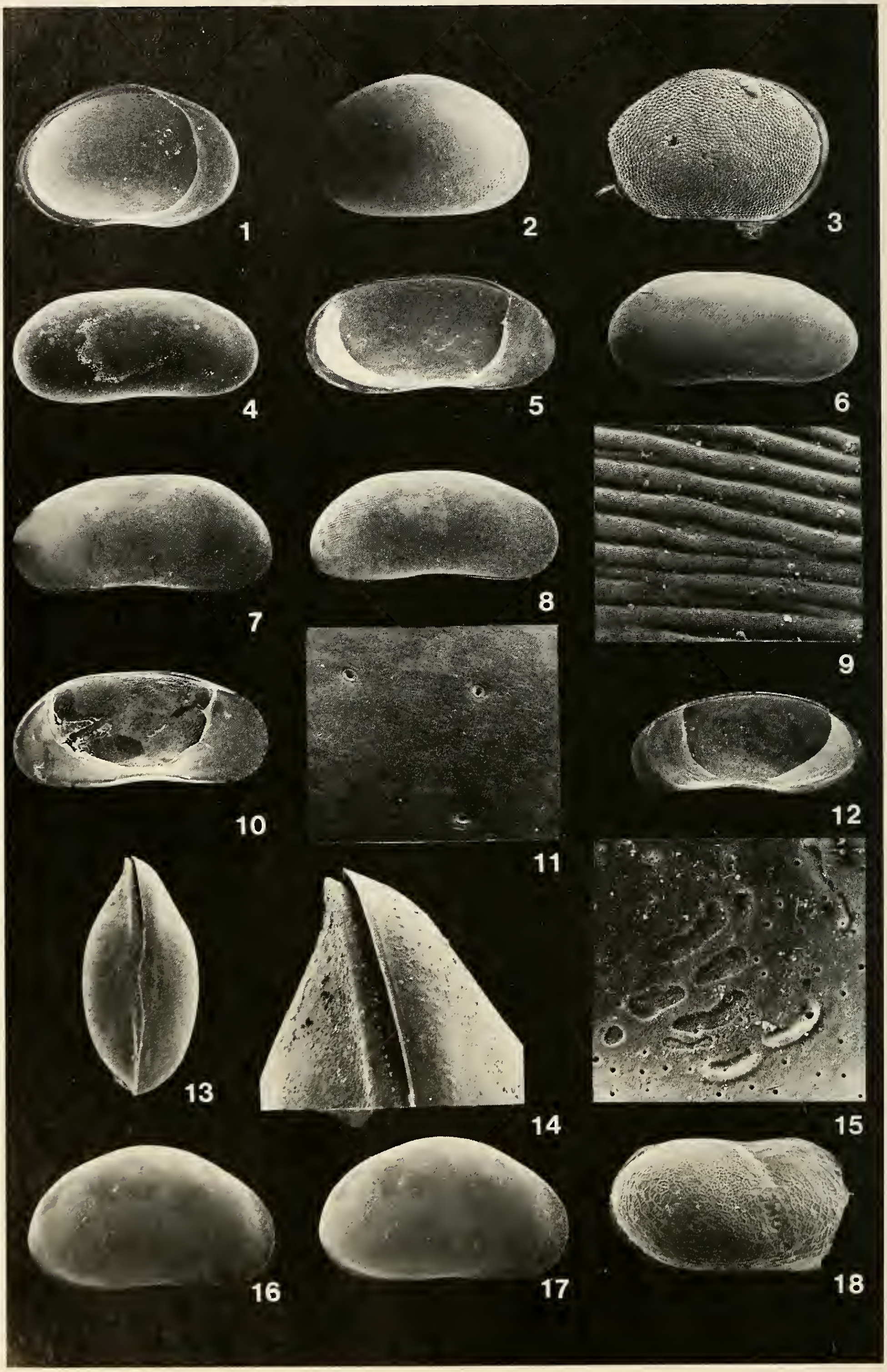
N. fenestrata is a very active swimmer and was most often found in open water less than 30 cm deep near the edge of the lagoon where it reached densities of up to 300/litre. Unlike *C. minna* it was rarely collected in association with dense growths of vegetation.

N. fenestrata did not appear until September, 1981, but from then all life stages were present although, when the lagoon was at its maximum depth (46 cm in the sampling area) and there was a lush growth of *Myriophyllum,* the species was not commonly found at the regular sample sites. It was, however, present at high densities on the edge of the lagoon in areas of relatively low turbidity. This suggests that open, clear waters of depths less than 0.5 m are its preferred habitat. As with *C. minna* few adults were present in March, 1982.

3. *Ilyodromus varrovillius* (King, 1855); *Ilyodromus viridulus* (Brady, 1886).

Size: females 1.7 mm and 1.3 mm; males 1.6 mm and 1.2 mm respectively; Figs 4-11.

Ilyodromus was formerly considered to be endemic to the Australian Zoogeographical Region but recently females of the genus have been found in the Philippines (Victor and Fernando, 1981). It also occurs in some European ricefields, but only as parthenogenetic populations (Fox, 1965). Thus, it seems probable that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bisexual populations remain confined to the Australian Region. The significance of this pattern was discussed by McKenzie (1971).

Ilyodromus varrovillius is dark greenish when mature and has distinct surface striations on both valves, whereas *Ilyodromus viridulus* has smooth valves and is a paler colour. These two species occur together in several localities, presumably occupying different ecological niches but just what that difference is was not revealed by the sampling methods used in this study. Both occurred regularly in mud samples where they were found burrowed into the mud and also on the mud surface. During sorting they were seen moving freely through the mud on the surface of the container but they were not seen swimming. They were also found in both water and vegetation samples but they had almost certainly been picked up from the mud-water interface in both instances.

4. *Candonocypris candonioides* (King, 1855).
Size: females 1.8 mm, males not found; Fig. 12.

Candonocypris candonioides belongs to another genus endemic to the Australian Zoogeographical Region and when mature it is greenish and has an elongated bean-shape. There is a distinct selvage in the right valve. It is much less common than any of the species already mentioned and was only collected on five, non-consecutive occasions over the twelve months suggesting that, at least since its first appearance in November, it was always present but at much lower densities than the other species.

Adult *C. candonioides* were most frequently found in mud samples where they had burrowed into the mud. Again, they also occurred in water and vegetation samples but, as in the case of the two other benthic species, they were probably picked up from the mud surface. According to De Deckker (1981a) the adults are not known to swim but the juveniles swim quite strongly.

C. candonioides may be a junior synonym of *C. novaezelandiae* (Baird), as suggested by De Deckker (1981a), but the Australian species name is preferred here.

5. *Heterocypris vatia* (De Deckker, 1981)
Size: females, 2.2 mm; males 1.9 mm; Figs 13-17.

Mature individuals of this species are brownish-orange and have weak crenulations on the ventral right valve.

H. vatia was found in shallow water towards the edge of the lagoon at depths of less than 0.5 m and also in isolated shallow pools on the mud flats around the edge of the lagoon. It was seen in large numbers crawling rather sluggishly over the mud surface but was not observed swimming. By November the density had declined and it had disappeared by December. It was not seen after that time except for one individual found in a sample collected near the edge of the lagoon in July, 1982, at a site which was first inundated in mid-March of the same year. This is perhaps indicative of *H.*

Figs 1-18 **1.** *Cypretta minna* (King) male, internal left valve (LV), x46. **2.** *C. minna;* female, external right valve (RV), x38. **3.** *Newnhamia fenestrata* (King) female, external RV, x42. **4.** *Ilyodromus viridulus* (Brady) female, external RV, x32. **5.** *I. viridulus;* male, internal LV, x28. **6.** *I. viridulus;* male, external LV, x34. **7.** *Ilyodromus varrovillius* (King) male, external LV, x28. **8.** *I. varrovillius;* female, external RV, x24. **9.** *I. varrovillius;* female, external LV, detail of striation, x54. **10.** *I. varrovillius;* female, external RV, x24. **11.** *I. viridulus;* male, external LV, detail of normal pores, x54. **12.** *Candonocypris candonioides* (King) female, internal RV, x24. **13.** *Heterocypris vatia* (De Deckker) female, ventral view, x20. **14.** *H. vatia;* female detail of RV anteroventral denticulation, x58. **15.** *H. vatia;* female, internal LV, detail of central muscle field, x96. **16, 17.** *H. vatia;* female, external RV stereo pair, x20. **18.** *Gomphodella australica* (Hussainy) female, external broken RV, x48.

SEM micrographs by the Electron Microscope Unit, University of New England, Armidale.

vatia being a pioneer species. Its appearance and disappearance coincided within one month of two other pioneer species: the notostracan *Lepidurus viridis* and a conchostracan species. Neither of these is mentioned in two previous studies of the lagoon invertebrate fauna (Timms, 1970, and Maher, 1976). As these two studies were undertaken at times when the lagoon had not been dry for some years it seems probable that the eggs of both those species require a period of desiccation before hatching can occur. A similar explanation would account for the records of *H. vatia*.

6. *Gomphodella australica* (Hussainy, 1968).
Size: female 0.85 mm; males not found; Fig. 18.

When mature, *Gomphodella australica* is brownish-purple with a heart-shaped carapace. It has a cytheracean, as distinct from a cypridacean, anatomy with three post-abdominal lobes.

Only one individual of this species was found. It was collected in November in a vegetation sample, which contained associated algae, from water 14 cm deep. This agrees quite well with De Deckker's (1981b) statement that it is usually found crawling amongst filamentous algae at depths of 0.5-1.0 m. De Deckker placed this species in the new genus *Gomphodella* because of the lack of the peripheral lateral ridge around the flat base of the valves which is characteristic of *Gomphocythere* Sars, 1924, to which it was referred previously.

All of the ostracod species found in Llangothlin Lagoon are considered indicative of good quality waters (McKenzie, 1980). This will make them useful indicator species when monitoring the effects of management plans to be implemented in the future.

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